Chemical Processing

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Chemical processing is the final step in preparing the phosphate rock for use in fertilizer. It conditions the insoluble rock so it will dissolve and be available to the plants that are fertilized. Today that means running chemical processing plants to produce phosphoric acid, which provides the highest grade phosphate at the lowest delivered cost.

The bulk of this phosphate - 90 percent - is used to make fertilizer to increase the quality and yield of crops needed to feed the world. Another 10 percent is used to make animal feed, food-grade phosphoric acid and commercial chemicals.

Phosphoric acid is produced when phosphate rock is reacted with sulfuric acid. A by-product of this reaction is phosphogypsum, which is similar to natural gypsum but contains trace amounts of radium and metals found with the phosphate in the ground.

The Florida Institute of Phosphate Research funds studies that look into the efficiency and environmental topics and issues related to the chemical processing of phosphate. Much of FIPR's work in this area strives to find safe, economical ways to use the millions of tons of phosphogypsum that is stockpiled in stacks because the U.S. Environmental Protection Agency (EPA) currently bans the by-product's use due to the trace amount of radium it contains.

Recent chemical processing research topics range from improving chemical processing efficiency and transportation of phosphate materials to putting phosphogypsum to use and using phosphate to immobilize lead in contaminated soil.

Current Research Efforts in Chemical Processing

Using Phosphogypsum

FIPR currently is funding research into using phosphogypsum to speed decomposition in landfills, create a marine substrate, make glass tiles, replace the need to create borrow pits to find fill for road banks and to build a road. Such projects are designed to study the practicality, feasibility, safety and economics of potential uses.

LANDFILLS: In landfills, a series of FIPR-funded projects are showing that the use of phosphogypsum in municipal solid waste (MSW) landfills speeds bacterial decomposition and extends the landfills' life. Since landfills are lined it is believed that phosphogypsum would not create an environmental problem. The current project demonstrates that phosphogypsum accelerates real MSW decomposition and is producing a practical procedure for phosphogypsum use in a landfill operation.

This could extend the life of existing landfills, the demand for which increases each year. In Florida, about 19.5 million tons of MSW were produced in 1991 and by 2010 the yearly production of MSW is expected to increase to 30 million tons. About half of this waste ends up in landfills and the demand for landfill space continues to grow.

Using Phosphogypsum, cont.

MARINE SUBSTRATE: Another project mixed phosphogypsum with binders such as portland cement, sand and/or fly ash to make composites that would act as a hard substrate on which marine organisms, such as oysters, can settle and grow. The study also tested the substrate as a base for coral reef growth in Florida waters. Such structures are needed and it appears that there is no reason for concern with bioaccumulation of the impurities found in phosphogypsum.

Phosphogypsum Statistics

- More than 900 million tons of phosphogypsum are currently stockpiled in Florida in stacks, like the one pictured above, due to environmental regulations banning its use.
- Phosphogypsum is a by-product created when sulfuric acid is reacted with phosphate rock to make the phosphoric acid used in fertilizer
- A phosphogypsum stack can be as high as 200 feet and cover as many as 400 acres of land
- There are more than 20 phosphogypsum stacks in Florida
- 30 million new tons of phosphogypsum are produced yearly

The study showed that suitable substrate can be produced, but the economics connected with such production is in question.

GLASS: Another FIPR project is showing that phosphogypsum can be used to make glass products such as roofing tiles. The process would also produce sulfuric acid, which is a marketable commodity for the phosphate industry. Radon emanation is greatly suppressed by converting radium-bearing materials into glass and so it could be possible under current EPA regulations to utilize phosphogypsum for making safe glass products. The ultimate goal of this project would be to operate a demonstration plant that would develop engineering data to be used to design a full-scale commercial plant to produce phosphogypsum-based glass products.

ROADS: Using phosphogypsum in road building is an ongoing topic of FIPR research since studies show the by-product to cost less and be as effective, if not more, than traditional road building materials. Monitoring of early test roads also show the material does not significantly impact the environment.

A series of current projects are compiling technical data needed to seek an EPA exemption to use phosphogypsum to build a road on land where a deed restriction prohibits future homebuilding. The Polk County Commission would like to see phosphogypsum used in road building to save money and offers the deed restriction as a way to protect against the EPA risk scenario that led to the ban of such use. This work is outlined on page 2 of this report.

Since phosphogypsum could also be used as fill for road building, a related study has also compared the environmental and economic impacts of creating borrow pits or using phosphogypsum to as a fill material for things like overpass embankments. Many borrow pits become attractive additions to the landscape, others are shallow holes that attract mosquitoes and trash. Using phosphogypsum could reduce the need to create borrow pits.

The project shows that, overall, using phosphogypsum would create less negative environmental impacts than digging borrow pits.

Projects Completed Since June 1997

Magnesium Separation from Dolomite Phosphate by Acid Leaching

Completed 12/29/98; conducted by Science Ventures/Douglas Laird

This project showed that treating phosphate rock with a weak acid can solubilize the dolomite in the rock so that it can be removed as a solution. A process such as this would be economically attractive since the magnesium in the dolomite can be recovered and sold.

This is one of many FIPR projects exploring different techniques and technologies to remove the high magnesium dolomite from the phosphate deposit being mined to the south, where the mining is moving as the Bone Valley reserves are depleted.

Magnesium can be one of the most troublesome impurities in phosphate rock. High quantities of magnesium present in the manufacture of phosphoric acid means more sulfuric acid will be used and there will be lower production rates and yields. Because of the problems, much high magnesium phosphate is left in the ground or, if it is mined, part of it is discarded.

Removal of Unwanted Metals and Materials in Phosphatic Acid by Means of Magnetic Separation

Completed 11/13/97; conducted by University of South Florida

This project demonstrated that it is possible to use magnetic separation to lower the iron content of phosphoric acid. It also demonstrated that magnetic separation could be used to dissolve the scale that forms in the pipes of a phosphoric acid manufacturing facility.

This is important because iron, along with aluminum and magnesium, are impurities found in phosphate rock that create problems in the manufacture of phosphoric acid and makes it difficult to meet specifications on DAP (diammonium phosphate) fertilizer.

Dissolving scale is important because of the nature of phosphoric acid production and phosphoric acid itself forms scale on the piping and equipment. This problem is currently controlled with a parallel pipe system that allows one to be washed while the other is used for the acid.

Elimination and/or control of the scale formation could lower operating costs for the production plants.

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Processing

Current FIPR projects to improve processing efficiency look at impurities such as iron in phosphoric acid, using phosphoric acid instead of sulfuric acid to dissolve phosphate rock and phosphogypsum production issues.

IMPURITIES: Reacting phosphate with sulfuric acid produces a phosphoric acid with many impurities, the most important of which are iron, aluminum and magnesium. These have a negative impact on the phosphoric acid production process and on the quality of the fertilizers that are subsequently produced with the acid.

FIPR is funding a project that tests a method to precipitate dissolved iron and then separate it from the phosphoric acid. The study assesses how well different low-cost additives remove the iron without impacting phosphoric acid production. It considers the recovery of phosphate values and filtration rates as well as investigating the optimum operating, design and economic conditions. The goal is to find a cost-effective way to remove at least 30 percent of the iron.

DISSOLVING PHOSPHATE ROCK: A project building on previous FIPR work will better define the conditions that are necessary to maintain acceptable filtration rates in a process that uses phosphoric acid to dissolve the phosphate rock instead of sulfuric acid.

The previous work developed process modifications and showed that this process has several benefits such as using less sulfuric acid and producing a purer phosphoric acid. It has never been proven practical, however, because filtration rates are lower than those for the conventional wet acid process, which simply reacts phosphate rock with sulfuric acid.

PHOSPHOGYPSUM PRODUCTION: A project building on previous FIPR work shows in a pilot plant that treating ground phosphate rock with carbonate flotation removes calcium and magnesium. This process is cost effective because it reduces the amount of sulfuric acid, defoamer and supplemental nitrogen needed to produce phosphoric acid and DAP. The lime and dolomite removed can be sold and the amount of phosphogypsum produced can be reduced.

In another FIPR-funded project, bench-scale results indicate that low-cost surfactants can be used to improve phosphoric acid yields and produce phosphogypsum that contains less phosphoric acid. Improved separation of phosphogypsum from phosphoric acid can result in higher production rates, lower production costs and fewer environmental problems.

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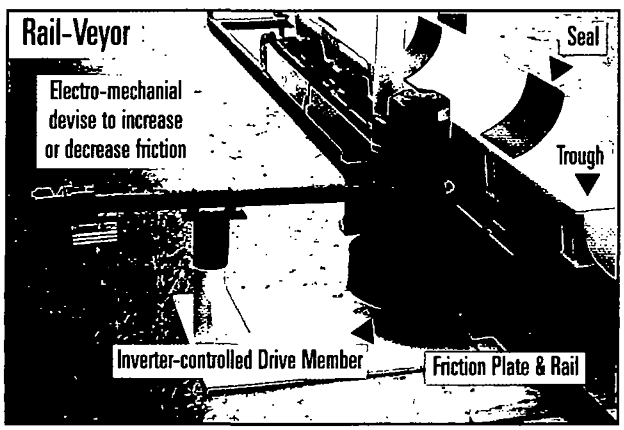
Cleaning Metal-Contaminated Soils

U.S. EPA currently has more than 1000 contaminated soil sites listed on a priority remediation list nationwide, 52 of which are in Florida. The Sapp Battery Salvage Site in northwest Florida is one of these and is the site of a FIPR-funded project demonstrating that mixing phosphate with metal-contaminated soil is a low-cost way to immobilize the lead. The study also is looking at how phosphate impacts CU, Ni, Cadmium and Zinc and how the treatment impacts groundwater and soil.

While lab tests have shown that phosphate will immobilize lead, the technology has not been used because it has not been demonstrated on an actual contaminated site until now. The reason so many sites have yet to be remediated is cost. Current techniques would cost $3 to $26 million to remediate the 23-acre Sapp site. Using a phosphate source like the rock, granular super triple phosphate (GTSP), or phosphatic clay would significantly reduce remediation costs.

Transportation

One of the largest costs in phosphate mining is the cost of transporting the matrix from the dragline to the plant. It is an energy-intensive operation that includes mixing the phosphate matrix with water to create a slurry that can be pumped to the washer. There is always a danger of a pipeline leak or break in the current pumping system.



FIPR is currently funding a project that is designing and testing a less costly and energy-intensive system to move solid matrix. The system, Rail-Veyor, is a train that has no engine or driver. It is powered by a series of stationary friction drive stations and runs on lightweight rails. Rail-Veyor is a series of inter-connected cars that form a continuous trough, which would carry the matrix. If this project proves the system to be cost-effective and reliable, it could provide a low maintenance, environmentally attractive alternative to transport matrix over sensitive landforms. Department of Environmental Protection (DEP) officials agree and are interested in this concept. They also think the system could be used to transport sand needed in beach rebuilding projects.

Another FIPR-funded project is working on creating a way to transport other phosphate industry solids in magnetically propelled cars that speed through a pipeline that can be either above or below ground. This project is outlined on page 3 of this report.